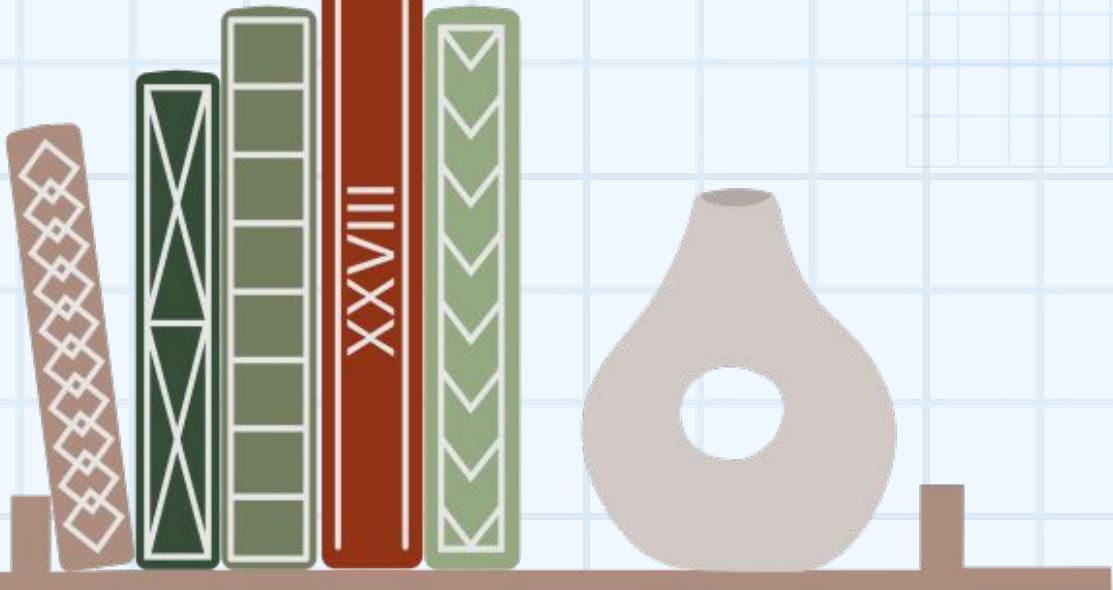




# BS./BSc.

in Applied AI and Data  
Science

## Number system: Base conversion





# Content

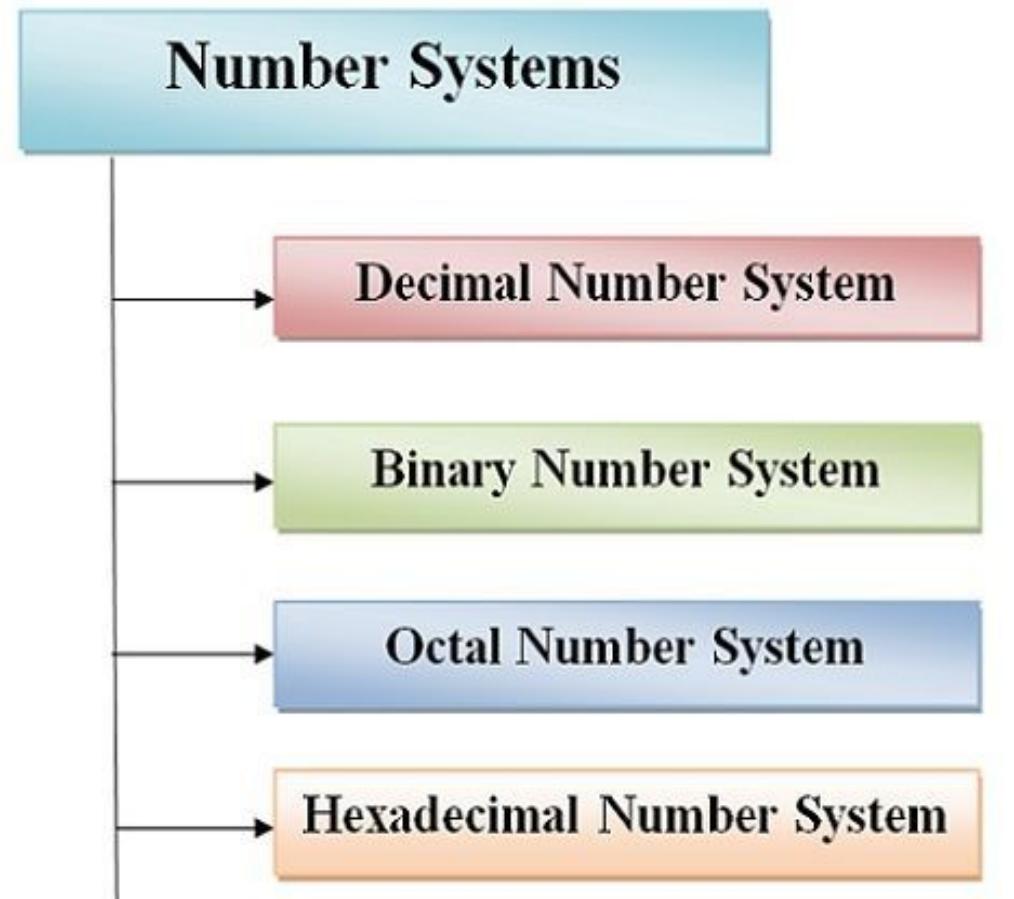
- Introduction
- Number system types
- Conversions
- Summary





# What is a Number System?

- A number system is a writing system for expressing numbers; it is a mathematical notation for representing numbers of a given set, using digits or other symbols in a consistent manner.
- Common systems: Decimal (base 10), Binary (base 2), Octal (base 8), Hexadecimal (base 16)



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# Decimal System (Base 10)

- The decimal system is the standard system for denoting integer and non-integer numbers.
- It is also called the base 10 system, using digits from 0 to 9.
- Example:  
Number: 347 (Decimal)



# Binary System (Base 2)

- The binary system uses only two digits: 0 and 1.
- It is used by almost all modern computers and computer-based devices because it is straightforward to implement with digital electronic circuitry.
- Example:  
Number: 1101 (Binary)



# Octal System (Base 8)

- The octal system uses digits from 0 to 7.
- It is used as a shorthand for binary numbers because it is easier to read and write than long binary numbers.
- Example:  
Number: 173 (Octal)



# Hexadecimal System (Base 16)

- The hexadecimal system uses digits from 0 to 9 and letters A to F (representing values 10 to 15).
- It is often used in computing as a more compact representation of binary data.
- Example:  
Number: 2F3 (Hexadecimal)



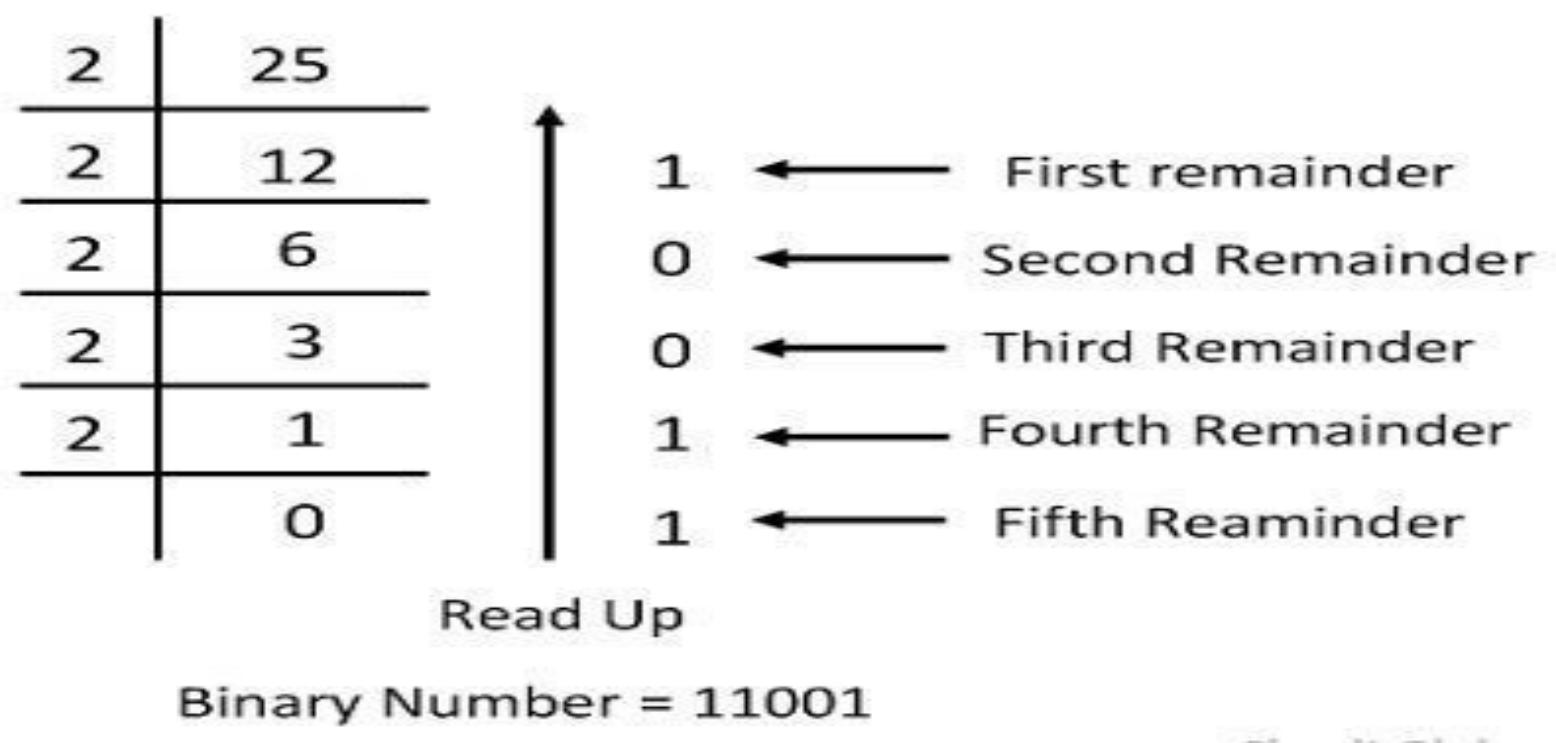
# Base Conversion Overview

- Base conversion involves converting a number from one base to another (e.g., Decimal to Binary).
- Common conversions:
  - ❑ Decimal to Binary
  - ❑ Binary to Decimal
  - ❑ Decimal to Octal
  - ❑ Octal to Decimal
  - ❑ Decimal to Hexadecimal
  - ❑ Hexadecimal to Decimal



# Decimal to Binary Conversion

- To convert a decimal number to binary, repeatedly divide the decimal number by 2, recording the remainder for each division.
- Example: Convert 25 to Binary





# Continued.....

## *Python code:*

```
python

def decimal_to_binary(decimal_num):
    return bin(decimal_num)[2:]

# Example usage:
decimal_number = 13
binary_number = decimal_to_binary(decimal_number)
print(f"Decimal {decimal_number} to Binary is: {binary_number}")
```

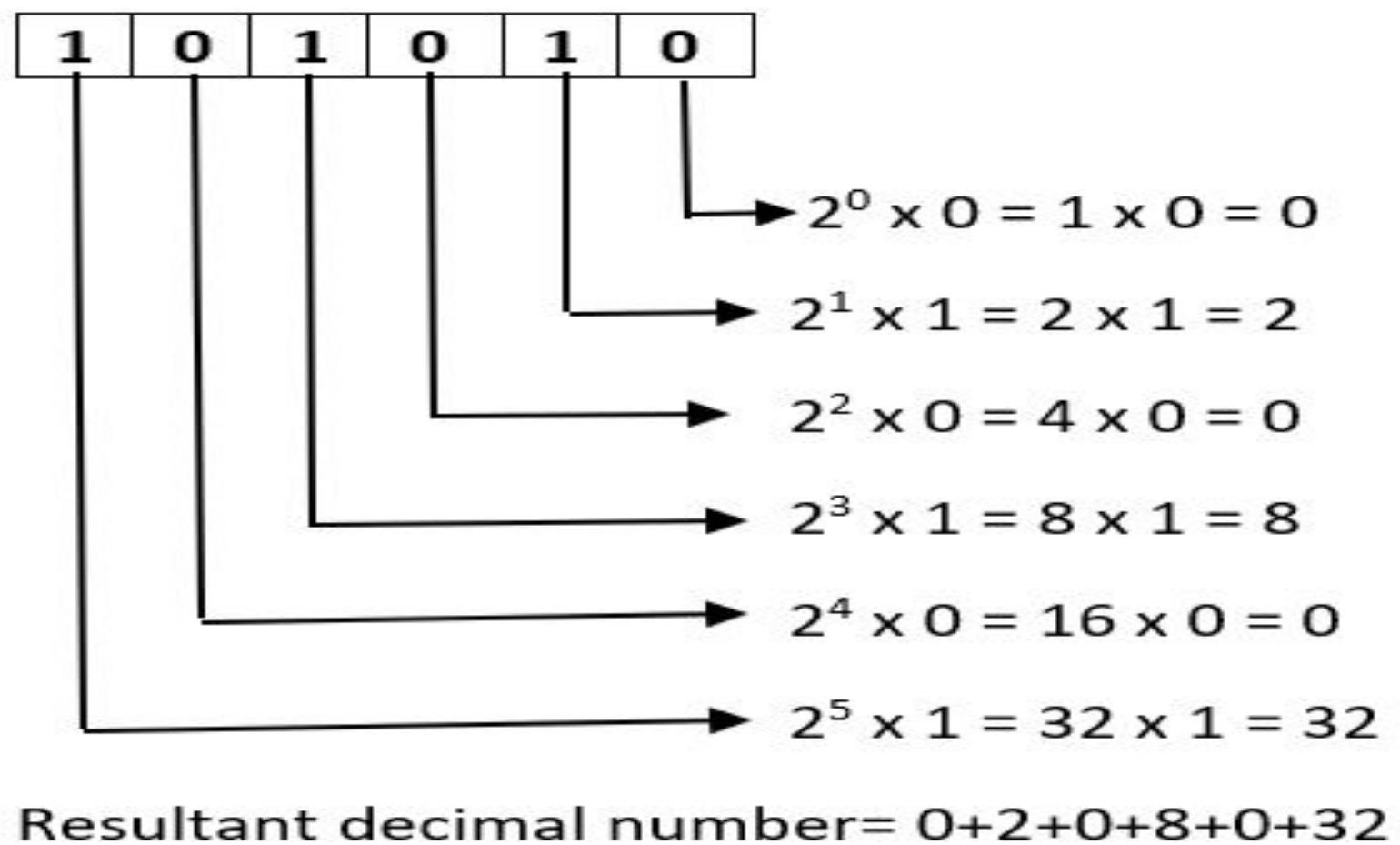
## *Explanation:*

- The `bin()` function in Python converts the decimal number to binary.
- The `[2:]` slice removes the `0b` prefix.
- Example: Decimal 13 → Binary 1101



# Binary to Decimal Conversion

- To convert a binary number to decimal, sum the products of each digit and the corresponding power of 2.
- Example: Convert 101010 to Decimal





# Continued.....

## *Python code:*

```
python

def binary_to_decimal(binary_num):
    return int(binary_num, 2)

# Example usage:
binary_number = "1101"
decimal_number = binary_to_decimal(binary_number)
print(f"Binary {binary_number} to Decimal is: {decimal_number}")
```

## *Explanation:*

- The `int()` function converts a binary string to a decimal by specifying 2 as the base.
- Example: Binary 1101  
→ Decimal 13



# Decimal to Octal Conversion

- To convert a decimal number to octal, repeatedly divide the decimal number by 8, recording the remainder for each division.
- Example: Convert 136 to Octal

## Decimal to Octal Conversion

	Number	Remainder
8	136	0
8	17	1
8	2	2
0		

A yellow arrow points from the bottom right corner of the remainder column to the text "Number now becomes zero".

$$(136)_{10} = (210)_8$$



# Continued.....

## *Python code:*

```
python

def decimal_to_octal(decimal_num):
    return oct(decimal_num)[2:]

# Example usage:
decimal_number = 65
octal_number = decimal_to_octal(decimal_number)
print(f"Decimal {decimal_number} to Octal is: {octal_number}")
```

## *Explanation:*

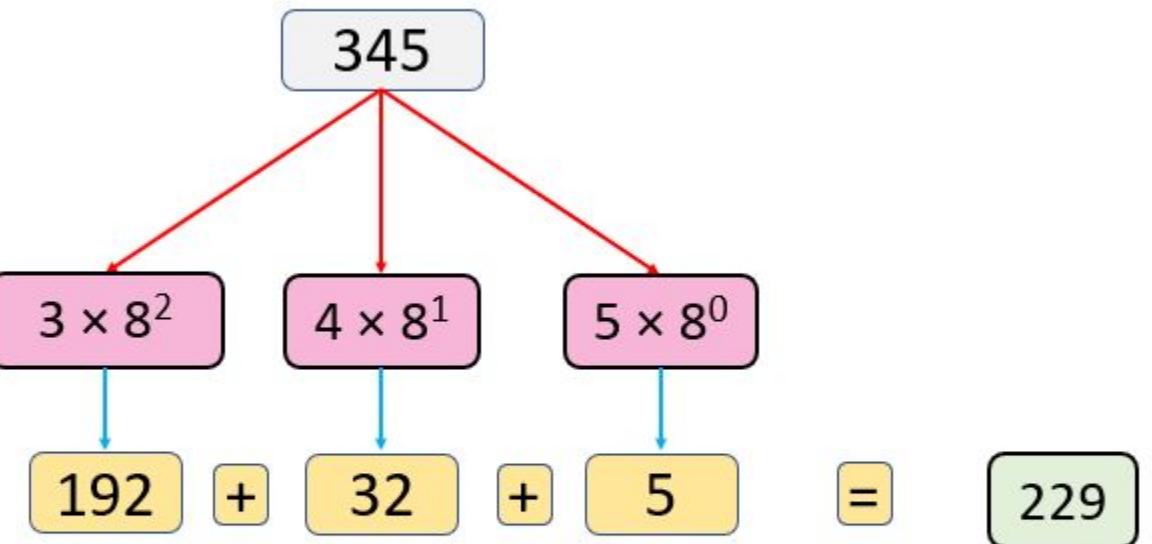
- The `oct()` function converts the decimal number to octal.
- The `[2:]` slice removes the `Oo` prefix.
- Example: Decimal 65 → Octal 101



# Octal to Decimal Conversion

- To convert an octal number to decimal, sum the products of each digit and the corresponding power of 8.
- Example: Convert 345 to Decimal

## Octal to Decimal Conversion



$$(345)_8 = (229)_{10}$$



# Continued.....

## *Python code:*

```
python

def octal_to_decimal(octal_num):
    return int(octal_num, 8)

# Example usage:
octal_number = "101"
decimal_number = octal_to_decimal(octal_number)
print(f"Octal {octal_number} to Decimal is: {decimal_number}")
```

## *Explanation:*

- The `int()` function converts an octal string to a decimal by specifying 8 as the base.
- Example: Octal 101 → Decimal 65



# Decimal to Hexadecimal Conversion

- To convert a decimal number to hexadecimal, repeatedly divide the decimal number by 16, recording the remainder for each division.
- Example: Convert 269 to Decimal

$$(269)_{10} = (?)_{16}$$

		Remainder
16	269	13 (D)
16	16	0
16	1	1
	0	

↑       $(10D)_{16}$

$$(269)_{10} = (10D)_{16}$$



# Continued.....

## *Python code:*

```
python
Copy

def decimal_to_hexadecimal(decimal_num):
    return hex(decimal_num)[2:].upper() # Converts to uppercase for better readability

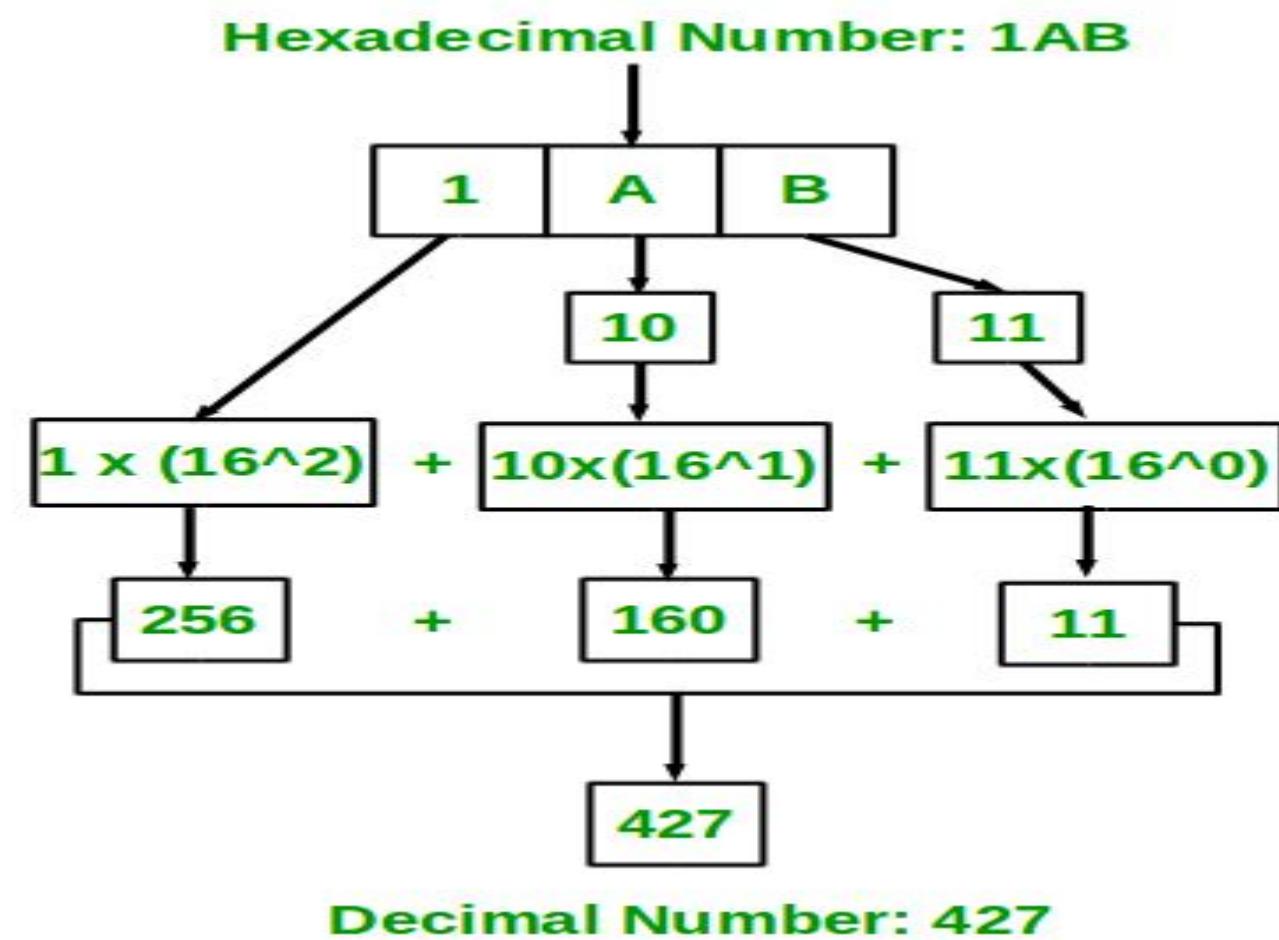
# Example usage:
decimal_number = 254
hexadecimal_number = decimal_to_hexadecimal(decimal_number)
print(f"Decimal {decimal_number} to Hexadecimal is: {hexadecimal_number}")
```

## *Explanation:*

- The `hex()` function converts the decimal number to hexadecimal.
- The `[2:]` slice removes the `0x` prefix.
- Example: Decimal 254 → Hexadecimal FE

# Hexadecimal to Decimal Conversion

- To convert a hexadecimal number to decimal, sum the products of each digit and the corresponding power of 16.
- Example: Convert 1AB to Decimal





# Continued.....

## *Python code:*

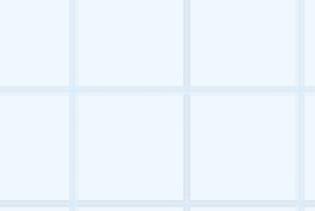
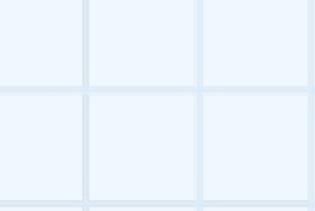
```
python

def hexadecimal_to_decimal(hex_num):
    return int(hex_num, 16)

# Example usage:
hexadecimal_number = "FE"
decimal_number = hexadecimal_to_decimal(hexadecimal_number)
print(f"Hexadecimal {hexadecimal_number} to Decimal is: {decimal_number}")
```

## *Explanation:*

- The `int()` function converts a hexadecimal string to decimal by specifying 16 as the base.
- Example: Hexadecimal FE → Decimal 254



# Got Questions? Let's Solve Them Together!





# Summary of Base Conversions

- ❖ Decimal to Binary: Divide by 2, record remainders.
- ❖ Binary to Decimal: Sum products of binary digits and powers of 2.
- ❖ Decimal to Octal: Divide by 8, record remainders.
- ❖ Octal to Decimal: Sum products of octal digits and powers of 8.
- ❖ Decimal to Hexadecimal: Divide by 16, record remainders.
- ❖ Hexadecimal to Decimal: Sum products of hexadecimal digits and powers of 16.



# Thank you

